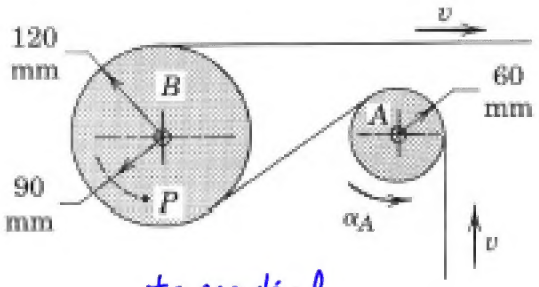
The two pulleys are operated by the tape which passes over them without slipping. During start-up the speed v of the tape increases from 1.2 m/s to 2.4 m/s with constant tangential acceleration while 600 mm of tape have passed over the pulleys. When the speed approaches 2.4 m/s, determine the angular acceleration α_A of pulley A and the magnitude a_p of the total acceleration of point P fixed to pulley B.



tangential

Tape with constant acceleration $v^2 = v_0^2 + 2a_t s$

$2.4^2 = 1.2^2 + 2a(0.600)$, $a = a_t = 3.6$ m/s^2

Pulley A: $a_t = r\alpha$, $\alpha_A = 3.6/0.060 = \boxed{60 \text{ rad/s}^2}$

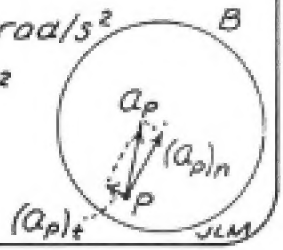
Pulley B: $v = r\omega$, $\omega_B = 2.4/0.120 = 20$ rad/s

$(a_p)_n = r_p \omega^2 = 0.090(20)^2 = 36$ m/s^2

$a_t = r_B \alpha_B$, $\alpha_B = 3.6/0.120 = 30$ rad/s^2

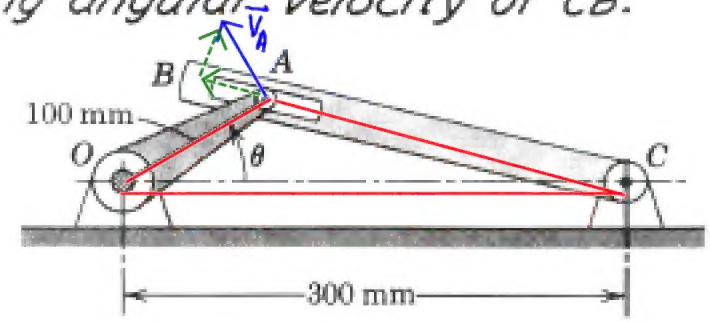
$(a_p)_t = r_p \alpha_B = 0.090(30) = 2.7$ m/s^2

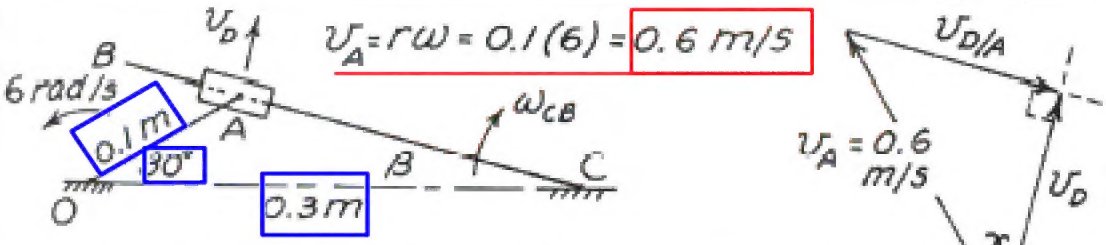
$a_p = \sqrt{(a_p)_n^2 + (a_p)_t^2} = \sqrt{36^2 + 2.7^2} = \boxed{36.1 \text{ m/s}^2}$



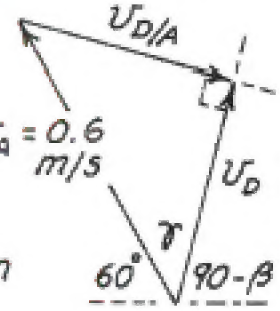
JLM

Crank OA oscillates about the $\theta = 0$ position causing CB to oscillate in turn. If OA has a counterclockwise angular velocity of 6 rad/s when $\theta = 30°$, determine the corresponding angular velocity of CB.





$v_A = r\omega = 0.1(6) = \boxed{0.6 \text{ m/s}}$



$\underline{v}_D = \underline{v}_A + \underline{v}_{D/A}$ where D is a point on CB coincident with A

$$\beta = \tan^{-1}\frac{0.1 \sin 30°}{0.3 - 0.1 \cos 30°} = 13.19°$$

$60° + \gamma + 90° - 13.19° = 180°, \quad \gamma = 43.19°$

$v_D = v_A \cos\gamma = 0.6 \cos 43.19° = 0.437 \text{ m/s}$

$\overline{CD} = \overline{OA} \sin 30°/\sin\beta = 0.1(0.5)/0.228 = 0.219 \text{ m}$

$\omega_{CB} = v_D/\overline{CD} = 0.437/0.219 = \boxed{2.00 \text{ rad/s}}$

JLM

1/ Find velocity of A
$\vec{V}_A = 0.6$ m/s ↖ 60°

2/ Determine all angles and lengths of sides of triangle OBC

3/ Break up $\vec{V}_A$ into components that are parallel & perpendicular to ABC

4/ $(V_A)_{perp} = (AC)(\omega_{BC})$ ✓ ✓

Question 3: mie 200 midterm test 2003

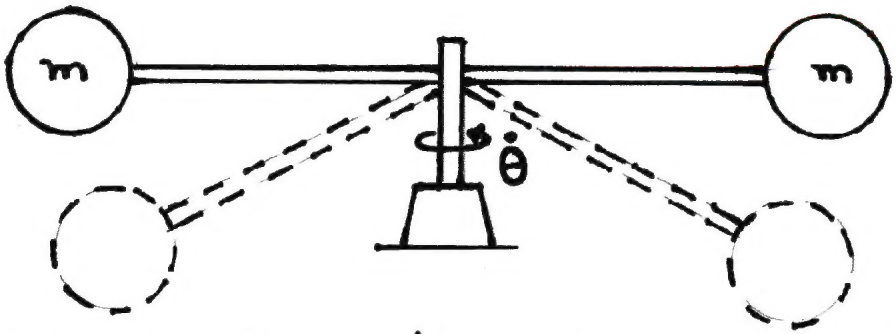
(15)

The mechanism shown rotates about the vertical axis with an initial angular velocity of $+2\ s^{-1}$. Initially, the two masses are in a horizontal plane, as shown by the solid lines. A hinging system internal to the mechanism then lowers the two masses 30 degrees from the horizontal plane, as shown in the diagram by the dashed lines. The masses are each 600g and the original distance of each mass from the rotating axis is 200mm.

(a) If the mechanism is freely spinning (i.e. there is no friction), what is the angular velocity of the mechanism after the masses are lowered? position 1 → position 2

(b) A motor on the shaft is then turned on for 3 seconds, and returns the rotational speed of the shaft to $+2\ s^{-1}$. (The masses stay in the dashed configuration.) What is the average moment supplied by the motor? position 2 → position 3

(c) How much work was done by the motor? position 2 → position 3.



(a) No external moments applied → $(H_o)_2 = (H_o)_1 = (2m)(r)(r\dot{\theta})$

$2m(r^2\dot{\theta})_2 = 2m(r^2\dot{\theta})_1$

$(0.2\cos 30°)^2\,\dot{\theta}_2 = (0.2)^2(2\,s^{-1})$ → $\boxed{\dot{\theta}_2 = 2.667\ s^{-1}}$ Does gravity affect result?

(b) $(H_o)_3 = (H_o)_2 + (M_{average})(\Delta t)$

$2m(r^2\dot{\theta})_3 = 2m(r^2\dot{\theta})_2 + (M_{average})(3)$

$(2)(0.6)(0.2\cos 30)^2(2) = (2)(0.6)(0.2\cos 30)^2(2.667) + (M_{ave})(3)$

$0.072 = 0.096 + (M_{ave})(3)$ → $\boxed{M_{average} = -0.008\ N\cdot m}$

(c) $T_3 = T_2 + U_{motor}$

$(2)(\tfrac{1}{2}mv^2)_3 = (2)(\tfrac{1}{2}mv^2)_2 + U_{motor}$

$(0.6)(0.2\cos 30)^2(2)^2 = (0.6)(0.2\cos 30)^2(2.667)^2 + U_{motor}$

$0.072 = 0.128 + U_{motor}$

$\boxed{U_{motor} = -0.056\ Joules}$